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Research practice and productivity on electronic resources in India: Scientometrics study based on Scopus database

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Abstracts:

This paper aims to examine research practice and performance on the electronics resources in India during the year 2011 to 2020 on different parameters namely yearly research growth, relative growth rate and doubling time, forms of research, most prolific authors and Institutions, Collaborative country, degree of collaboration, and funding agency etc. The data of the current research paper about electronic resources indexed in the Scopus database have been retrieved. The records with topic search (includes Title, Abstract, Keywords and Keywords Plus) "Electronic resources" were extracted. MS Excel and VOS viewer have analyzed these data. The search result shows that a total of 1482 papers have indexed in the Scopus database during 2011-2020. The study reveals that numerous research papers have been published on electronic resources in India. 2019 is the leading (288 papers) producer of research papers," Library Philosophy and Practice" is the leading (64 papers) source of publications, *Bhat, N.A, Jha, M.K* and *Thanuskodi, S* are the prolific authors, the *United States* is the highest (78 Papers) collaborated country and degree of collaboration (DC) = 0.92, "*Department of Science and Technology, Government of Kerala"* is the highest (13 papers) funding agency for the topic electronic resources research in India.

Keywords: *Electronic Resources; Scientific Research; Scientometrics; Scopus; Research productivity.*

1. Introductions:

Today libraries are delivering electronic gate to a wide assortment of resources, including files, full-text articles, and complete back volume of records and Internet/Web resources. Libraries have been moving towards an electronic domain, in which adequate PCs are necessary to get access to a variety of electronic information resources. The array of electronic resources accessible in the libraries today is a result of computer technologies, namely, personal computers, huge storage device, a delivery mechanism such as CD-ROM and user-friendly graphical user interface. These advances put forth the on-going attempts to supplant other customary administrations and cycles with electronic renditions appealing and financially plausible for some libraries. The new field of research is rapidly emerging, and Scientometrics analysis of the different subject is also gaining popularity. Electronic Resources research is one such burning area which has grown exponentially in the last few decades, and there is no Scientometrics study has been conducted in India on electronic resources. The present study attempts to highlight the research productivity of researchers in the area of Electronic Resources in India. This study focused on different Scientometrics parameters such as the growth of literature in the field of Electronic Resources, pattern of authorship, most prolific institution and organization, publication growth rate and Journal coverage of the researcher in the field of Electronic Resources etc. According to Bookstein: Scientometrics as “the science of measuring Science” (Brindha, 2016). Scientometrics also regarded as bibliometrics measurement for evaluation of scientific development, social relevance and impact application in science and technology.

2. Review of Literatures:

Wuni, Shen & Osei-Kyei (2019) have explored global research productivity on green building from 1992 to 2018. The study analyzed a total of 1147 research articles for this study from 1992 to 2018. It revealed that research on the green building was increased exponentially from 1992 to 2018. It found that 44% of countries are highly engaged in the research activity on the green

building; major ten broad themes on the green building were identified and suggested for future research. Finally, this paper provides new insight into the original researcher, funding agencies, policymakers and other professional about the research progress in the field of green buildings (Wuni et al., 2019)

Kumar, Suchetan & Rahaman (2019) have found out research productivity on big data in India from 2010 to 2019. They found 7502 research articles on big data in the Scopus data during the study period of 10 years. All the data has been downloaded from Scopus and analyzed with the help of Microsoft Excel and Vosviewer software. The study focused on different Scientometric parameters including research performance, yearly research output, authorship pattern, International Collaboration, and Institute wise research collaboration, DC and relative growth rate & doubling time. The study revealed that most of the research published is in the form of conference papers (53.57%), highly research subject in the field of big data was "Computer Science". It found that RGR decreased from 2010 (0.73) to 2019 (0.25 but DT of research publications increased 0.95 (2010) to 2.72 (2019), most popular sources of research published in the field of big data was "The advances in Intelligent Systems and Computing" having 422 papers. And DC of research is 0.93. The study also revealed that research publications have been increasing exponentially due to collaboration of the subject experts in the field (Kumar, Suchetan & Rahaman, 2019)

Khadeeja. M.N. Ansari et al.. (2019) have demonstrated research productivity of Kumaun University, Nainital during 2000 to 2019.It found that Kumaun University has produced complete 1574 research publication over the study period. The author downloads the research data from Scopus and Analyzed with the help of Microsoft Excel and VOSviewer. The study focused on different parameters including total research productivity, yearly performance, type of research publication, most prolific authors, subject-wise research publications, highly cited authors and collaboration patterns etc. The study revealed that most preferred Journal by Kumaun University authors is "Current Science", the year 2017 have the highest research publication, and the most popular subject was "Agricultural and Biological Science". The study demonstrated that this type of research is essential to find out research gap and increase research performance among the scientist (Khadeeja.M.N.Ansari, 2019)

Utieyineshola (2018) has assessed the research productivity of African Countries in the field of Science and Technology from 1996 to 2015. The Study data has been retrieved from SCImago database over the year 1996-2015, which has seven major subject areas cutting across 126 Categories of Subjects. The literature was searched on SCImago with complete publication all over the world then refined the result with African over 20 years. All the data has been analyzed with the help of Microsoft Excel and presented by graph and tables. The study only took the most 10 Productive countries of Africa in the field of Science and Technology of all Selected Subject areas in SCImago. Paper has suggested that Intra-African Collaboration among the performing countries should be an option for developing the needed knowledge capacities to achieve the target of the regional developmental plan (2063) (Utieyineshola, 2018)

Khanna, Singh, Tewari & Saini (2017) have investigated research productivity of physics and Astronomy of the Guru Nanak Dev University, Amritsar during 2006-2015. A total of 652 data has been retrieved from Scopus database in the field of physics and astronomy. The study focused different Scientometric tools such as Year wise research output, productive authors, a preferred journal for communication, national and international collaboration pattern, and a number of citation received by the university during 2006 to 2015. The study revealed that the average citation impact of the university is 7.07% per paper, six research papers received 51 to 100 citations, Guru Nanak Dev University ranked 23rd among all the Indian Universities in terms of research performance (652) in the field of physics and astronomy, H-Index (29), 16th ranked in average citation per paper (7.01%), 18th ranked in the share of high cited papers (1%), 19th ranked in terms of international collaborative papers (27.45%) during the study period. The study also showed that 68.71% of publication has national Collaboration between Guru Nanak Dev University in physics and astronomy. It cleared that Journals are the most preferred form of a publication by a research scientist (Khanna et al., 2017)

Pradhan & Ramesh (2017) have demonstrated research output by the IIT, Mumbai and IIT, Madras in the field of Engineering Science, and it is sub-field from 2006 to 2015. The study analyzed 5378 research papers of IIT Madras and 4430 papers of IIT Mumbai in the field of Engineering Science. The study revealed that the number of research papers increased during 2006 to 2016, the researcher of both IITs published their research work in International Journal from United States of America, United Kingdom, and Germany, IIT Madras researchers

published 19.66% papers. IIT Mumbai researcher published 26.54% articles in the area of Engineering Science over the study period, IIT Mumbai authors less cited while IIT Madras authors were more highly cited (Pradhan & Ramesh, 2017).

3. Objectives:

1) To find out yearly research performance in the field of electronic resources
2) To find out the relative growth rate and Doubling time in electronic resources
3) To know the most prolific authors in electronic resources
4) To understand the published form of document in electronic resources
5) To find out the most productive journal.
6) To know the most funding agencies in electronic resources
7) To find out the Degree of Collaboration and pattern of Authorship.

4. Methodologies

Study data has been collected from the Scopus database (Elsevier, 2004), which is a very famous International Citation Database. To retrieve research data, following search strategy is used "TITLE-ABS-KEY (electronic AND resources) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012) OR LIMIT-TO (PUBYEAR, 2011)) AND (LIMIT-TO (AFFILCOUNTRY, "India"). Total 1482 documents found, which have been refined by using the period from 2011 to 2020 and Country name "India". Then the data imported and saved as an MS Excel file for further analysis. The Collected data were analyzed and interpreted using the VOSviewer (software tool for bibliometric analysis) (Nees Jan van Eck, 2020) and Microsoft Excel for further details analysis to meet the objective of the study.

5. Data Analysis and Interpretations:

5.1. Yea wise research productivity: The following revealed the year-wise distribution of publication from 2011 to 2020.

Table: 1 Yearly research output:

SL.No	Year	No of Research Publication	Percentage (%)	Cumulative of Publications
1	2011	69	4.65	69
2	2012	78	5.26	147
3	2013	101	6.82	248
4	2014	104	7.03	352

5	2015	149	10.05	501
6	2016	204	13.76	705
7	2017	177	11.94	882
8	2018	262	17.68	1144
9	2019	288	19.44	1432
10	2020	50	3.37	1482
	Total	**1482**	**100**	

The table 1 shows that research publication is increasing exponentially every year. During the last ten years, there are total 1482 research has been done in India on electronic resources (e-resources) The year 2019 has highest papers 288(19.44%) on the electronic resource in India, followed by the year 2018 (262) papers. The year 2011 has the lowest 69 (4.65) papers. The year 2020 is showing only 50 documents as it is not cover the entire year. The table also reveals that the cumulative publication in 2011 is 69 only whereas it is 1482 in the year 2020. So research is growing very fast on electronic resources in India.

5.2. Relative growth rate and doubling Time (RGT and DT): The relative growth and doubling time model was sophisticated by Mahapatra in 1985, and this model is useful to study relative growth rate of research publications (Mahapatra M, 1985)

Relative growth rate:

The relative growth rate is the increased in the number of research publications/articles or pages per unit of time, and it can be calculated with the following equations.

R (1−2)=$W1-W2T2-T1$

Where R (1-2) means the relative growth rate over a specified period of interval

W1=Log w1 (Natural log of the initial number of publications/Pages)

W2=Log W2 (Natural log of the final number of publications or pages)

T2-T1= the unit difference between the initial time and final time

The relative growth rate for both publications and pages can be calculated separately.

Therefore,

R (a) = Relative growth rate per unit of time (Year)

R (p) =Relative growth rate per unit of pages, per unit of time (year)

Doubling Time:

It is found from the equation that there is a direct relationship between relative growth rate and doubling time. If the number of research publications/ articles/pages of a subject double during the given period then the difference between the logarithms of numbers at the beginning and end of this period must be the logarithms of number two. If one uses natural logarithms, then this difference has a value of 0.693. Thus the corresponding doubling time for publications and pages can be calculated by the following equations. Dt= 0.693R

Where, DT =Double time, R= Relative growth

Therefore,

Doubling time for publications data can be calculated as (a)= 0.693R(a)

Doubling time for pages can be calculated as (p)= 0.693R(p)

Table: 2 RGR& DT

SL.No	Year	No of Research Publication	Cumulative of Publications	W1	W2	RGT	DT
1	2011	69	69	-	4.23	-	-
2	2012	78	147	4.23	4.99	0.76	0.91
3	2013	101	248	4.99	5.51	0.52	1.33
4	2014	104	352	5.51	5.86	0.35	1.98
5	2015	149	501	5.86	6.22	0.36	1.93
6	2016	204	705	6.22	6.55	0.33	2.10
7	2017	177	882	6.55	6.78	0.23	3.01
8	2018	262	1144	6.78	7.04	0.16	4.33
9	2019	288	1432	7.04	7.27	0.26	2.66
10	2020	50	1482	7.27	7.30	0.03	23.10
	Total	**1482**					

Table 2 demonstrate that the relative growth rate (RGT) is decreasing from 0.76 (2011) to 0.03 (2020), but in the case of doubling time, it is increasing from 0.91 (2011) to 23.10 (2020). It is clear from the above table that the relative growth rate is declining while doubling time is rising. From the table, it found that RGT and DT have a direct relationship between them.

5.3. Type of research in Electronic Resources: The following table show the form of research conducted in India on electronic resources.

Table: 3 Form of Research:

S. No	Type of Documents	Number of Publications	Percentage (%)
1	Article	712	48.04
2	Conference Paper	599	40.41
3	Review	83	5.60
4	Book Chapter	67	4.52
5	Book	12	0.80
6	Editorial	02	0.13
7	Letter	01	0.06
8	Note	01	0.06
9	Undefined	05	0.33

The above table 3 examines the form of research conducted in India on the topic of electronic resources. The table reveals that most of the research papers 712 (48.04%) published in the form

of the article, followed by conference papers 599 (40.41%). The letter (1paper) and note (1paper) have the lowest form of research on electronic resources. The other research forms are Review (83 papers), Book chapter (67 papers), Twelve books and Editorial (02 papers). Out of 1482 papers, only 05 papers marked as "undefined".

5.4. Most Prolific authors in Electronic Resources: The following table 4 recognizes the top ten authors/s with their names, the number of publication and their ranks.

Table: 4 Prolific Authors

S. No	Author Name	Number of Publication	Rank
1	Bhat, N.A	8	1
2	Jha, M.K	8	1
3	Thanuskodi, S	8	1
4	Ashok, S	7	2
5	Chatterjee, K	6	3
6	Ganaie, S.A	6	3
7	Ali, M.K	5	4
8	Kumar, V	5	4
9	Ajay, V.S	4	5
10	Chitra, A	2	6

Table 4 displays the most prolific authors on electronic resources in India during 2011-2020. The most prolific authors, namely *Bhat, N.A, Jha, M.K* and *Thanuskodi, S* have contributed eight papers each to electronic resources and raked one, followed by *Ashok, S* is the 2nd highest contributed (7 papers) author. Chatterjee, K and Ganaie, S.A produced six papers each. Ali, M.K and Kumar yield five papers each. Chitra, A is the lowest (02 papers) contributor in the table.

5.5. Most productive Sources: The following revealed the Source of publication.

Table: 5 Sources of publication

S. No	Source of Publication	Number of Publication	Percentage (%)
1	Library Philosophy and Practice	64	4.31
2	Desidoc Journal of Library and Information Technology	35	2.36
3	Advances In Intelligent Systems and Computing	33	2.22
4	International Journal of Applied Engineering Research	23	1.55
5	International Journal of Innovative Technology and Exploring Engineering	20	1.34
6	ACM International Conference	15	1.01

	Proceedings Series		
7	International Journal of Recent Technology and Engineering	14	0.94
8	Annals of Library and Information Studies	13	0.87
9	Electronic Library	12	0.80
10	Library Management	05	0.33

The above table 5 indicates the Source of publication on the electronic resource in India. It clear from the table that the International Journal "*Library Philosophy and Practice*" is the leading producer of research on electronic research publications 64 (4.31%), followed by Indian famous national level journal entitled "*Desidoc Journal of Library and Information Technology"* is the 2nd highest contributor of research publications 35 (2.36%), *Advances In Intelligent Systems and Computing* (33 papers), "*Annals of Library and Information Studies"* (13 papers) and "*Electronic Library"* (12 papers). The journal "*Library Management*" is the least contributor (05 papers).

5.6. Institution wise Research: The following table examines the wise institution research in India.

Table: 6 Institution Affiliations

S. No	Name of Institutions	Number of Publication	Percentage (%)
1	Vellore Institute of Technology, Vellore	34	2.29
2	Alagappa University	26	1.75
3	Anna University	26	1.75
4	IIT Delhi	26	1.75
5	University of Kashmir	22	1.48
6	University of Delhi	21	1.41
7	IIS	18	1.21
8	National Metallurgical Laboratory India	17	1.14
9	Amity University, Noida	17	1.14
10	Jadavpur University	16	1.07

Table 6 portrays the top ten leading institutions in India, "Vellore Institute of Technology, Vellore" is the highest (34 papers) affiliated institutions, followed by "Alagappa University" and "Anna University" and IIT Delhi (26 papers) each. The "University of Kashmir" is the 3rd highest producer (22 papers) of electronic resource research. The other affiliated institution's contributions are "The University of Delhi" (21 papers), IIS (18 papers), National Metallurgical

Laboratory India and Amity University, Noida (17 papers) each. Among the leading top ten, Jadavpur University is the lowest (16 papers) producer of research.

5.7. Country Wise Collaboration: Following table study, the country wise Collaboration of research on electronic resources in India.

Table: 7 Country wise collaboration

S. No	Name of County	Number of Publication	Percentage (%)
1	India	1482	100
2	United States	78	5.26
3	United Kingdom	35	3.36
4	Australia	31	2.09
5	China	20	1.34
6	Canada	17	1.14
7	South Korea	16	1.07
8	France	14	0.94
9	South Africa	14	0.94
10	Germany	10	0.67

The table reveals that "The United States" (78 papers) is the leading collaborated country, followed by the United Kingdom (35 papers). Australia is the 3rd highest (31 papers) collaborated country with India. The other top ten collaborated countries are China (20 papers), Canada (17 papers), South Korea (16 papers), France and South Africa (14 papers) each. Germany is the lowest (10 papers) collaborated country among the top ten countries.

5.8. Authorship pattern: Following table 8 examines the authorship pattern.

Table 8: Authorship pattern

S.No.	Year	Single Author	Joint authorship	Total
1	2011	09	60	69
2	2012	07	71	78
3	2013	10	91	101
4	2014	09	95	104
5	2015	18	131	149
6	2016	10	194	204
7	2017	09	168	177

8	2018	18	244	262
9	2019	22	266	288
10	2020	00	50	50
	Total	**112**	**1370**	**1482**

The above table 8 shows the authorship pattern in India on the topic of electronic research. The table clearly shows that during the study period (2011-2020), a comprehensive 1482 papers have published on electronic resources. Out of 1482 papers, only 112 papers are contributed by single authors only, and 1370 papers contributed by joint authorship. The table shows that in 2011, out of 69, only nine papers are single authorship while 60 papers are joint authorship but in 2019, out of 288 papers, 22 papers are single authorship, and 266 papers are joint authorship. It is found that there is an increasing trend on joint authorship among the scientist of India on the topic of electronic research.

5.9. Degree of Collaboration:

The degree of collaboration is the ratio of the number of co-author or collaborative research publications to the total number of research publications in a particular subject area during a specific period. The analysis of the collaboration of the author was given by Subrahmanyan to find out the Degree of Collaboration (Subramanyan, 1983). The formula for degree of collaboration $DC = \frac{Nm}{Nm+Ns}$

Table 9 shows the degree of collaboration in research on electronic resources during 2011-2020.

Table 9: Degree of Collaboration

S. No	Years	Single author (Ns)	Multi-Authors (Nm)	Total no. of articles (Ns + Nm)	DC
1	2011	09	60	69	0.86
2	2012	07	71	78	0.91
3	2013	10	91	101	0.90
4	2014	09	95	104	0.91
5	2015	18	131	149	0.87
6	2016	10	194	204	0.95
7	2017	09	168	177	0.94
8	2018	18	244	262	0.93
9	2019	22	266	288	0.92

10	2020	00	50	50	1.00
	Total	**112**	**1370**	**1482**	**0.92**

Table 9 depicts the degree of collaboration during the last ten years (2011-2020). It shows that the degree of collaboration level has been increased from 0.86 in 2011 to 1.00 in 2020. The study reveals that multiple authors contribution is 92% and single-author contribution is 8% on the topic of electronic resources in India. So the study shows that the researcher is more active to research collaborative ways.

The degree of collaboration for the ten years study period can be calculated as:
$DC = NmNm+Ns$
(*Nm* = multi-authored research; *Ns*= Single authored research)
DC= 1370/1482
DC = 0.92 (The degree of collaboration over the year 2011 to 2020 = 0.92).

5.10. Funding Agencies: The below table shows the research papers by the funding agencies in India.

Table: 10 Funding Agencies

S. No	Funding Agencies	Number of Publication	Percentage (%)
1	Department of Science and Technology, Government of Kerala	13	0.87
2	Department of Science and Technology, Ministry of Science and Technology, India	08	0.53
3	Science and Engineering Research Board	08	0.53
4	University Grant Commission	08	0.53
5	National Institutes Health	07	0.47
6	Department of Science and Technology, Ministry of Science and Technology	06	0.40
7	NCMIC Foundation	05	0.33
8	National Science Foundation	05	0.33
9	VIT University	03	0.20
10	Academy of Scientific and Innovative Research	02	0.13

Table 10 shows funding agencies that help the researcher to research in electronic resources in India." *The Department of Science and Technology, Government of Kerala,*" is the leading (13 papers) funding agency, followed by "*Department of Science and Technology, Ministry of Science and Technology, India","* Science and Engineering Research Board" and "University

Grant Commission" (08 papers) each. The "*Department of Science and Technology, Ministry of Science and Technology"* is the 3rd leading (06 papers) funding agency, while "NCMIC Foundation" and National Science Foundation" (05 papers) each. The "Academy of Scientific and Innovative Research" is the lowest (02 papers) producer of research on electronic resources in India.

Findings:

- The year 2019 has highest papers 288(19.44%) on the electronic resource in India
- The relative growth rate (RGT) is decreasing from 0.76 (2011) to 0.03 (2020)
- Doubling time is increasing from 0.91 (2011) to 23.10 (2020)
- Most of the research papers 712 (48.04%) published in the form of the article
- The most prolific authors, namely *Bhat, N.A, Jha, M.K* and *Thanuskodi, S* have contributed eight papers each to electronic resources in India.
- The International Journal "*Library Philosophy and Practice*" is the leading producer of research on electronic resources 64 (4.31%).
- Vellore Institute of Technology, Vellore" is the highest (34 papers) affiliated institutions
- The United States" (78 papers) is the leading collaborated country
- 112 papers are contributed by single authors only, and 1370 papers contributed by joint authorship
- The degree of collaboration over the year 2011 to 2020 = 0.92
- *The Department of Science and Technology, Government of Kerala,*" is the leading (13 papers) funding agency

Conclusion:

From the analysis of the current papers, it has found that research practice and productivity have been increased from 4.65% to 19.44% and The international journal namely "Library philosophy and practice" is the most impactful journal, published research on "electronic resources" 4.31% publications. "Electronic resources" are the fastest-growing field of study in the library and information science in India. The Scientometrics analysis allows the science policymakers and administrators to understand and hold the growth, development and impact of research and to recognize the countries, institutions and the specific researcher who are active in a particular field of research activity. This study provides researchers with an overview of Indian research on electronic resources through a systematic and comprehensive analysis of scientific output, core authors, significant institutions and countries, high impact sources, Collaborative research country in the field electronic sources research.

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